

EOS, Transactions, American Geophysical Union

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Aver D.C. call toll free 8 ashington, D.(Tectonophysics

BI30 Reat Flow (Past Temperatures from Morehole Data) DETERITIVATION OF SURFACT IDPERATURE HISTORY FROM MOREHOLE TEMPERATURE GRADIENTS F. Y. Shee and A. E. Reck (Department of Geophymics, University of Western Ontario, London, Canada Néa 537). The descrimation of surface temperature bistory from borshole temperature gradient profiles is commonly formulated as a linear least sequerature ministration problem. The surface temperature initiration problem. The surface temperature history is approximated by a series of intervals of constant temperature, and the beat solution obtained by systematically adjusting the number, duration and temperatures of these intervals so as to ministe the beature to the beatured the beatured to the seasured between the beatured to the calculated gradient profiles. However, this inversion problem is improparly possed. The gradient discurbances due to surface temperature parturbations in the series of time intervals are natually "almost linearly dependent". Thus the accuracy of a numerical solution is dictated by the level of random notice in the data and rounding errors in the computation. Unling effects of different holes levels, sampling transpessified and surface temperature history. The method of orthogonal polynomials in curve fitting is also used in an attempt to improve the time span and resolution. The results, however, indicate that under realization conditions, only shout A intervals of temperature perturbation can be used to approximate the history of surface temperature variations. The sajor implications are saturally exclusive; for example, with a resolution of conditions, the maximum time appar would be only 200 years is desired, the maximum time appar would be only 200 years.

the maximum time span would be only 200 years. (2) In order to have a reasonable resolution, the speche at which surface temperature changes took place must be known from independent information, because it impossible to approximate adequately the surface temperature history with a arbitrarily chosen time intervals of constant temperature. (3) Any surface temperature changes which took place outside the time span of internate must be known and their offects promoted from the gradient data; otherwise, interference from these temperature changes will lead to a distorted surface temperature history in the line span of interper.

Interest. J. Geophys. Res., Red, Paper 380751

8150 Plate Jectonics
BACKARC THRUSTING IN THE EASTERN SUNDA ARC, INDONESIA:
A CONSEQUENCE OF ARC-CONTINENT COLLISION
E. A. 51 Ner, (Earth Sciences, University of California, Santa Cruz, CA 95064), D. L. Roed, R.
McCaffrey, and Y. S. Joyodiwiryo
The structure of the eastern Sunda backarc region is dominated by two large north-directed thrusts, the Mater and Flores thrusts, and one or more minor thrusts, which may represent early stages of subduction polarity reverse of the arc. Cravity sliding or spreading are ruled out as primary driving mechanisms for the thrusts because slopes are a similar in areas of thrusting and non-thrusting. Collision by the Australian continencal margin is favored as the dominant mechanism, but slope stresses, forearc structure, and thermal weakening due to arc magmatism are seen as important factors facilisting the initiation of thrusting. (Collision tectonics, subduction, marine geophysics).
J. Geophys. Res., Red, Paper 380752

J. Geophys. Res., Red, Paper 3B0757

Volcanology

3130 Plate Tectorics
RABLY TERTIARY SURDICTION ZONES AND MOTSPOTS
Dones M. Jury (Department of Geological Sciences,
Marchmentern University, Evaneto, Illinois 60201)
Botapora and subduction names may control the
position of the marth's rotation shis. Paleomagnetic
reconstructions in the Notspot framework require a
relative action of about 10 hetween the hotspot
reference frame and the marth's polo axis since the
early Tertiary. If the viscosity of the mente
paratics, a changing distribution of mans's asselles
can control the position of the harth's rotation
axis as it tracks the maximum pracipal axis of the
perturbations. The pramest plate geometry should
alve the hest indication of the harth's rotation
axis as it tracks the maximum pracipal axis of the
perturbations. The pramest plate geometry should
alve the hest indication of what features are spenclated with the controlling density monesias. For
the present, secid-monesias indicate that subdecting
alabs are major mass controlling increases. Although
affects of template in the pole received alone
arrougly correlated with interpot locations. Although
seller the helapois slone nor subducting slabs alone
have sentimes principal axes are the present pole.
Moding the controlling of the two gives a combined
mais within a degree of the pole, suggesting that
them two effects control the location of the spin
scia. To assistian whather changes in plate, geometry
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direct observations, which give information about Minditerranean volcances, and indirect, etasphetic observations, which give at least the dates of an itempo emphosive oruptions that occurred somewhat Northern Healtphere. Sevan or more very large school or cruptions have been datested by these subods. Or observations indicate great emplices of These Northern Healtphere volcances in the years 27 E.A. 472). Indirect observations inply great emplies. Northern Healtphere volcances in the years 27 E.A. 172, AD 528, and AD 528. Some of the corrolations with known Healt terranean empties and corrolations with known Healt terranean empties.

891, 64 June 14, 1983

Imsactions, American Geophysical Union

IGY, which was to start July 1, 1957. While the cameras were being designed

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personnel. The final network is shown in Fig. ure 2. Network staffing was arranged to suit local conditions: Some stations were manned solely by U.S. citizens, some by foreign na-tionals, and some by mixed crews. SAO de-veloped the requirements for each site from the building design to the tools necessary for operation, although the basic plan was quite simple: a building to house the tracking camera and electronics and an office for administrative and data reduction functions.

Meanwhile, the amateur network, Moonwatch, was being rapidly organized with the help of astronomers worldwide. Observers were to use binoculars, or small telescopes, and stop watches to determine rough satellite positions, which would be radioed or telephoned to Cambridge, Mass., for retransmission to the camera stations as refined orbital predictions. Moonwatch team members were expected to furnish their own equipment; but SAO provided the design for building an inexpensive monoscope. In the end, Moonwatch evolved into two networks: a large network of observers using small telescopes capable of tracking objects to 7th-9th magnitude, and a smaller network of observers using larger telescopes capable of acquiring fainter objects. (This latter group would play a vital role later in the recovery of "lost" satellites.) By the summer of 1957, 80 active teams had been organized in the United States, with a similar number overseas. During that summer, simulation tests, using lights on aircraft, were conducted over a number of sites in the United States to check operational procedures and observer response. The U.S. Air Force played a very important role in the organization and setup of Moonwatch, and this close relationship and support continued

through the subsequent operational years of Staff recruitment for the Baker-Nunn camera network began in early 1957. The observatory looked for candidates who were eager and enthusiastic as well as responsible and versatile. It got pioneers: do-it-yourself indi-viduals who could devise and implement a means to do any job. These people really built the network, first in the field and later in Cambridge, when many returned to help in the development and evolution of the headquarters operation.

Through marathon sessions at both Perkin-Elmer and Boller and Chivens, the first Baker-Nunn camera was completed on September 30, 1957, and was set up outside the plant in Pasadena for star tests (see Figure 3). From photographs taken October 2, it appeared that the camera was functioning, but some minor modifications and adjustments were necessary. It was estimated that this work would require about 2 weeks.

Thus, when Sputnik I was launched October 4, 1957, the first Baker-Nunn camera was in Pasadena, still in need of work. Moreover, communications facilities had yet to be established at SAO headquarters, and the orbital software was still being debugged. Fortunately, Moonwatch was operational. The first optical observations came from the Geophysical Institute in Alaska on October 4 and 5. The first confirmed Moonwatch observations also

Fig. 2. Sites of the Baker-Nunn camera stations.

came from Alaska on October 8 and then from a Connecticut team on October 10. These, and subsequent Moonwatch observations, were used to refine predictions on a day-by-day (and even hour-by-hour) basis for

the computations groups at SAO.

The visibility for Sputnik over Pasadena was poor in early October, so the Baker-Nunn Camera was disassembled and modified. It was back outside by mid-month; on October 17, the first photographs of Sputnik were taken (see Figure 4). From these photographs, it became evident that the tracking procedures required considerable improvement; although many frames had been taken, images appeared on only a few. (The camera actually photographed Sputnik's orbiting rocket body. In fact, it appears now that no western observer ever photographed the lirst Sputnik.) The camera remained at Pasadena for 3 weeks while tracking procedures were modified; it was then shipped to the first net work tracking station at Las Cruces, New

On November 3, the Russians launched Sputnik 2. To supplement the network on an interim basis, Super-Schmidt cameras from the Harvard Meteor Project were sent to Argentina and Hawaii to support tracking activi-

One of the biggest surprises and the first scientific discovery produced by tracking the Sputnik satellites was the large effect of air drag on orbiting bodies. The air density at orbital altitudes proved to be considerably larger than was expected. In addition, since it had been anticipated that the first satellite would be the U.S. Navy Vanguard, with an orbit much higher than Sputnik, the orbital software had made no accommodation for this air drag. As a result, early orbital predictions were often 5-10 min off, and the observers had to use elaborate search techpiques to find the satellites. The early predictions thus relied heavily on Moonwatch visual observations, and, on some occasions, direct elephone contact between the Las Cruces Baker-Nunn camera and Moonwatch stations was established to produce updates in real time. By early 1958, however, predictions had mproved considerably through the work of Luigi Jacchia, who developed models of atmospheric drag. (Jacchia used the same technique to predict accurately the demise of Sputnik 2 in April 1958.)

When the first U.S. satellite (Explorer 1, as it turned out, rather than Vanguard) was launched in January 31, 1958, Moonwatch observations were made almost immediate Baker-Nunn observations were provided by the new station in South Africa by mid-March. As the other cameras were completed, they were shipped immediately to the field stations by U.S. Air Force MATS flights. The schedule of deployment and dates of first satellite observations are shown in Table 1. By mid-1958, all 12 cameras were in operation.

Because of the rush to field the cameras and crews, insufficient time was devoted to many of the observational, timing, and data reduction techniques. As a result, each station, and in some cases each observer, developed individual and innovative methods. Some were very good; some were less so. These differences in technique often led to difficulties in correlating data from one station to another. Another major problem was the lack of a standard star chart. Star positions were available in tabular form, and some observers memorized portions of the sky. But it was not uncommon to take 6-10 hours to identify star backgrounds for an evening's observations. However, by late 1958, standardized operating procedures had been established for the field stations, and extensive communications, computations, and photoreduction facilities had been set up at SAO. With the new Mann X-Y measuring machines, satellite positions could be dete mined to 1-2 arcseconds, an accuracy compatible with 10 m determination of station position. Moonwatch continued to play a very fundamental role in the network; 230 teams had already been established with over 5000

ing to be a long-term national program. Consequently, following the ICY, sponsorship of SAO's Satellite-Tracking Program was assumed by NASA.

SAO also recognized early that the space program would evolve rapidly and that the rapid distribution of information on events and scientific research was essential. The observatory instituted the SAO Special Report Series as part of its overall program, with the first report, "Preliminary Orbit Information for U.S.S.R. Satellites 1957 Alpha 1 and Alpha 2," issued October 14, just 10 days after the Sputnik launch. Over the next five years. more than 100 reports were issued on the results of optical satellite tracking including models of atmospheric density and its variations with solar activity, geopotential modeling, atmospheric and ionospheric influences on radio and optical propagation, satellite dynamics, and celestial mechanics.

As the Space Age progressed, the Baker-Nunn cameras also demonstrated their full design capabilities: Vanguard 1, a 6-inch diameter sphere, was photographed at a range of 2400 miles; Explorers 6 and 12 were photographed at ranges of 14,000 and 16,000 miles, respectively. In addition to satellites. the camera was also used to observe comets. flare stars, artificially injected ion clouds, up per stage rocket firings, and gas dumps in

By the early 1960s, network operations had become more systematic and routine. Manuals and procedures were in use, and all stations provided data on a uniform basis. Star charts and improved geodetic models for orbit analysis were available, and many of the early equipment problems had been solved. Improved calibration procedures were available for photoreduction, together with more efficient methods of cataloging observations. Long are photography techniques had been developed, and simultaneous observation programs to measure baselines were introduced with the launch of the ANNA 1B satellite with flashing lights in 1962. The result was a steady improvement in data yield and efficiency (see Table 2). By the mid-1960s, the Photoreduction section of SAO was pro viding more than 50,000 precise positions per year. Moonwatch continued to be very active through the decade, with over 100,000 observations acquired by 1967. Although Moonwatch's role in producing predictions for the Baker-Nunn cameras had diminished somewhat, the network played an important role

Michael R. Pearlman received an S.B. in physics from M.J.T. in 1963, a Ph.D. in physics from Tufts University in 1968, and an S.M. from the M.I.T. Sloan School of Management in 1980. He oined the Smithsonian As-(SAO) in 1968 as a scien-

tist specializing in the areas of lasers, optics, and atmospheric propagation. In 1971–1972, he was a Visiting Scientist at the Office of Geodetic Satellites at NASA headquarters. Since 1972, he has been the Manager of the Satellite Tracking Program at

LIGHT SHIELD BACKUP PLATE FOCAL SURFACE THREE-ELEMENT CORRECTING SYSTEM SHUTTER -

success(u) observations. The IGY had assumed an 18-month program with only a few satellites. Yet, by the end of the IGY, there were already 11 satellites in orbit, and it was recognized that the international space program was just begin-ning. In July 1958, NASA was formed to take over responsibility for what was obviously go-

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Vol. 64, No. 24, Pages 409 - 416

but about 10" away in a location similar to the pole position required by palaconqueric studies. This suggests that changes is subduction geometry may cause a shift in the position of the rotation pole, and furtherzore, that inertia tuneer affects may be the link between plate velocities and the spin axis. (Motspots, subduction zone, spin axis, true pular wander).

THE ISOLATION OF STRATOSPHERIC TEMPERATURE CHARGE DUE TO THE RL CHICKON VOLCANIC REUPTION FROM MON-VOLCANIC RICHALS

R. B. Quiron (Climate Analysis Center, RMC, RMS, NOAA, Washingkon, D. C. 2023)

To isolate the stratospheric temperature signel due to the evention of El Chickón, Raviaco (March 18-April 4, 1982) requires consideration of temperature abenges of dynamic origin, changes related to the warning of the east equatorial Pacific ocean surface in 1982 (an El Riño event), and changes due to the quest-blandel oscillation (280). Dynamically-produced changes in low the high-latitude stratosphere from January to April are accounted for, clearing the way for the diagnosis of temperature changes after April. From compositing of stratospheric temperature scenalism during past Rl Mino events, it is described that temperature (287) changes should be negligibly small in summer 1982, while important thoreafter. For summer 1982 the remaining diagnostic problem involves estimating the residual secribable to the evention, From a resonetruction of past past Rl calculating the residual secribable to the evention. From a resonetruction of past past Rl calculating the residual secribable to the evention, From a resonetruction of past past Rl or calculating the residual secribable to the evention of past past Rl calculating the residual secribable to the evention should be due to the QNO and saludating the residual secribable to the evention should be due to the QNO and temperatures at 15-45°H (30 ab), astimates are obtained for QNO phase with latitude in 1982 and for comperature do the equator and 37 N. This say be oduly as well as a station of now-volcenion ignals. (Volcenic offents, temperature, etracosphere, lettlastolaity, 1,0-3,0°C between the equator and 3.5 N. This say be contracted with the equator and 3.5 N. This say be contracted with the equator and 3.5 N. This say be contracted as an obtained to the equator and 3.5 N. This say be contracted as a station of now-volcenion ignals. (Volcenic offents, Leapener (1882)

May 14-1 Cincinna

Fig. 1. Simplified cross-section view of the Baker-Nunn camera.

Program tracking, was to be launched at a low inclina-tion. Thus, most station sites were selected to M. R. Pearlman¹ provide low latitude coverage around the Smithsonian Astrophysical Observatory, Cambridge, Massachusetts 02138 world, with a few sites at slightly higher latiworld, with a rew sites at singuly night lati-tudes to provide enhanced geometry for geo-detic research. Other site requirements in-cluded good weather, good horizons, and reasonably good accessibility for the receipt and transmission of data, equipment, and

When Fred L. Whipple of Harvard University assumed the directorship of the Smithsonian Astrophysical Observatory (SAO) in mid-1955, he proposed to the National Academy of Sciences and the National Science idation that the observatory be given re-

Early Experience of the

SAO Satellite-Tracking

aneibility for optical tracking of satellites uring the IGY of 1957-1958. Several countries had expressed their intentions to launch saellites during the 18-month period to support research in ionospheric and upper atmopheric physics, including the effects of solar Hares and solar radiation, and in geodesy and cophysics. On the basis of his experience at he Harvard College observatory with the Suer-Schmidt cameras for meteor photograhy, Whipple was confident that optical tracking could provide a powerful means of

monitoring satellite positions. The proposal was accepted in late 1955, and it was assumed that the total observing program would last only 18 months and would involve only a few

By early 1956, Whipple, with the assistance of J. Allen Hynek, had designed a program determine the position of satellites illuminated in twilight periods by use of a network of 10-12 large aperture cameras based on the model of the Super-Schmidt. They also specified the requirements for communications and computations, as well as the need for a worldwide network of visual observers who would make preliminary observations to assist the large cameras in satellite acquisition. This volunteer network, later to be called loonwatch, ended up playing a far larger

role than was originally projected.

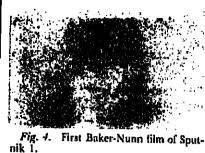
The optics of the special tracking camera were designed by James Baker of Harvard. Based on the specifications proposed for the Vanguard satellite. Baker designed an #1 camera with 20-incli-diameter aperture, a curved focal plane, and an elaborate three-clement corrector cell (see Figure 1). The mount and drive mechanism of the camera were designed by Joseph Nunn Associates. The camera, although it proved to be far were complicated, heavy, and costly than was originally anticipated, is a tribute to its designers. Many years later, the camera was still considered to be a formidable instrument of optimum design. The contract for the construction of the camera optics was awarded to Perkin-Elmer, and the contract for fabrication was given to Boller and Chivens in the autumn of 1956. The logistics of manufac-luring what was to be called the "Baker-Nunn amera" were formidable. The camera was a new design. Twelve units were built concurrently. No prototype and no real testing were

planned. The optics were fabricated on the east coast, the mechanics on the west coast. Plans called for the cameras to be assembled n Pasadena, California, with each shipped to its site as it was completed. Finally, the entire actwork was to be operational during the

and built, the process of site selection was under way. The Vanguard satellite, which was considered to be the prime candidate for

Presented at the AGU Fall Meeting, Reviews on Geodesy During the International Year, December 9, 1982.

Fig. 3. The first Baker-Nunn camera set up at Boller and Chivens



in the acquisition of "lost" satellites and in providing specialized tracking for atmospheric studies and long period perturbations. (The Moonwatch network would continue to operate on a limited basis until 1975 when it was disbanded.)

The scientific contributions of the SAO Sat-

TABLE 1. Shipping Schedule of Baker-Nunn Cameras and First Successful Observations

| Station | Date Camera Shipped | Date of First Observation | Object Photographed |
|--------------|------------------------|--|------------------------|
| New Mexico | November 2, 1957 | November 26, 1957 March 18, 1958 March 11, 1958 March 18, 1958 April 5, 1958 August 29, 1958 July 4, 1958 May 20, 1958 June 22, 1958 July 10, 1958 July 4, 1958 July 4, 1958 | 1957 α l |
| South Africa | February 3, 1958 | | 1958 alpha |
| Australia | February 22, 1958 | | 1957 beta |
| Spain | March 2, 1958 | | 1957 beta |
| Japan | March 30, 1958 | | 1958 alpha |
| Jadia | March 30, 1958 | | 1958 8 l |
| Peru | April 8, 1958 | | 1958 8 l |
| Iran | May 1, 1958 | | 1958 8 l |
| Curação | May 8, 1958 | | 1958 8 l |
| Florida | May 8, 1958 | | 1958 8 l |
| Argentina | May 15, 1958 | | 1958 8 l |
| Jawaii | May 15, 1958 | | 1958 8 l |

TABLE 2. Baker-Nunn Camera Predictions and Observations 1959-1967

| | Predictions | Observations | Percentage o Predictions Observed |
|----------------------|------------------------------------|----------------------------|---|
| Year 1959 | 22,463 | 6,524 | |
| 1960 1961 1962 | 3 2,491 61,632 70,379 | 12,249 19,520 | 29 32 40 |
| 1963 1964 1965 | 82,734 99,847 | 27,257 23,895 45,196 | 40 45 43 |
| 1966 1967 | 130,881 143,362 126,514 | 61,075 70,829 | 47 49 |
| Totals | 747,290 | 56,315 316,336 | 45 42 |

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GALE

ellite Tracking Program also became apparent in the 1960s. The first "Standard Atmo-

sphere," relying on large amounts of optical tracking data, was published in 1964. In 1966, the First "Smithsonian Standard Earth"

provided a geopotential model of the planet, as well as a grid of satellite-determined sta-

imilar models represented both the culmina-

tion of work that had begun during the IGY

and the precursor of future research in satel-

lite geodesy, geophysics, and upper atmo-spheric physics. The original goal of 10-m station positions at the time of the IGY has

evolved, 25 years later, into a goal of 1 cm.

The Baker-Nunn cameras were gradually

replaced by laser ranging systems in the 1970s, as SAO's mission of operational track-

ing changed to the support of scientific pro-

grams, particularly in earth dynamics. As the

original stations were relocated to provide ad

ditional geodetic coverage, many of the cam-

eras were decommissioned, and have since

been donated to university and research or-

ganizations for continued scientific use. Ap-

photographed the Sputnik I rocket body

from a machine shop yard in Pasadena and later saw service in New Mexico and Arizona

was officially transferred in 1980 to the Na-

of the collections marking the history of the

early Space Age.

tional Air and Space Museum to become part

Acknowledgments. The author acknowledges

his debt to Trackers of the Skies by E. Nelson

Hayes (published by H. A. Doyle, Cambridge

Mass., 1968) for much of the early history of

the SAO Satellite Tracking program recounted in this paper. The Smithsonian Astrophys-

ical Observatory and the Harvard College

Observatory are members of the Center for

propriately, the first Baker-Nunn, which had

tion positions, and a discussion on the geo-

detic prospects for the future. These and

A cooperative research project to study winter cyclonic development on the east coast of the United States is being planned by an informal consortium of universities and federal research laboratories. Known by the acronym GALE (Genesis of Atlantic Lows Experiment), the project is designed to provide detailed information on the role of air-sea interaction, boundary layer, and mesoscale processes in cyclogenesis and frontogenesis off

Rapid cyclogenesis off the Carolina coast often leads to severe weather in the heavily populated northeast corridor. Recent examples include the Presidents' Day snowstorm of February 18–19, 1979, which deposited 60 cm of snow on the Middle Atlantic States; the April 6-7, 1982, snowstorm and windstorm in which more than 50 people lost their lives; and the February 11-12, 1983, blizzard that paralyzed the northeast with record-breaking snowfall and freezing rain that caused 70 deaths. It is hoped that the detailed studies to be carried out in GALE will help improve the forecasting of such east coast cyclones.

Four university research teams have joined together in proposing the "core" research ef-fort for GALE. They are the State University of New York at Albany (SUNY), Drexel University, North Carolina State University (NCSU), and the University of Washington (UW). Support for the core research effort has been requested from the Atmospheric Sciences Division of the National Science Foundation (NSF). Researchers from the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA) will also participate in the core effort. Requests have been made to the National Center for Atmospheric Research (NCAR), NOAA, and

NASA for facilities and personnel support. The proposed core research effort for GALE calls for a 4-year program, centered around a 2-month field project from January 15 to March 15, 1985. Field facilities will be deployed over an approximately 2.5 × 10° km² area, extending from Savannah in the south to Wallops Island in the north and from Greensboro in the west to about 200 km off the Carolina coast to the east. Proposed field facilities include specialized satellite coverage, a dense mesonetwork of ground stations, augmentation of the National Weather Service (NWS) rawinsonde network, tethered and free balloons, meteorological towers, dig-itization of the NWS radars from Florida to New York, four Doppler radars, several research aircraft, microwave and infrared radiometers, additional meteorological buoys and a research ship off the Carolina coast, and a lightning detection system from Georgia to

Overall scientific guidance for GALE is the responsibility of the Scientific Steering Committee (SSC). The members of this committee are Peter V. Hobbs (UW), chairman; L. F. Bosart (SUNY), vice chairman; S. P. S. Arya (NCSU); D. Atlas (NASA/Goddard); D. A. Barber (NCSU); W. Bonner (NOAA/NMC); D. J. Perkey (Drexel); and R. J. Scrafin (NCAR). Ex officio members are R. A. Dirks-(NSF), P. H. Herzegh (NCAR), and C. W. Kreitzberg (Drexel).

It is anticipated that other scientists will wish to take advantage of the opportunities afforded by the research facilities to be mounted for GALE and the unique data base that should accrue from this project. Those wishing to participate in GALE are invited to submit, by October 1, 1983, to the chairman or vice chairman of the GALE SSC a brief statement of interest (Peter V. Hobbs, AK-40, University of Washington, Seattle, WA 98195; Lance F. Bosart, Department of Atmospheric Science ES-227, State University of New York at Albany, 1400 Washington Avenue, Albany, NY 12222). The statement should outline the research objectives, instrumentation and/or data requirements, field operational plans, and the anticipated source and level of financial support. These statements will be used to coordinate further planning for GALE.

This news item was contributed by Peter V. Hobbs, chairman of GALE.

Gravitational Field **Theories Combined**

Einstein's gravitation theory has been beset with problems for a long time. These problems are related to the extension of the theory to outer space. All measurements to test the theory have been done on or near earth, but a number of convincing theoretical arguments have been made to suggest that the tests do not adequately explain effects in space beyond the solar system. It seems that an additional, supplementary field may be re-quired in certain domains of outer space. In a new gravitational theory, which comines Einsteln's main theory with modificadons to explain supplementary field require-

ments, the Rumanian physicist, M. Bornes has developed a novel approach. In "On possible new theory of gravitation" (Nature senschaften, 70, 1983), Borneas proposes go eralized equations that explain why, for example, experiments done in our solar system satisfy Einstein's theory, whereas in certain domains of space, such results would not se isfy the modified theory.

Borneas notes that the main Einsteinian fields can be derived from the action prior ple, as follows from the space-time differen

 $\delta | d \times g \% (R \times Lm) = 0$

where R is defined as the scalar curvature space-time; the LM is the matter Lagranga More recent requirements include the addi-tion of a supplementary scalar field to this field. The approach in the new theory is to define a scalar field such that its confid varies in an acceptable way. The result work have the supplementary field approach zer in this solar system. In Lagrangian form to supplementary gravitational field is repre-

 $L_S = e f_{jk} f^{jk}$ (summation convention)

The e term is the factor related to circumstances in space and can vary from zero, Boneas accomplishes this by relating a to the metric gy and its variations, as follows:

 $\varepsilon = i \left(V_{jr}^{r} + \Gamma_{jr}^{r} V^{s} \right)$

in which $\Gamma_{ss}^{\ \ \nu}$ is the contracted Christoffel symbol, used here to build the appropriate scalar dependence. The v' is defined as a very small imaginary vector (not a measural field), a being a real scalar that depends on

Borneas' equation thus becomes

 $\delta g \mid dx + gV_2 (R + LM + Ls) = 0$

He notes the value of the Christoffel symbol as $(\Gamma_{jk}')0$ when it has the maximum value in the solar system. Thus it follows that

 $e = -i \left[\nabla_{h'} + (\Gamma_{sr}) \right]_{\alpha} \nabla^{s} = 0$

resulting in the supplementary field, under those conditions, approaching zero. These are the conditions under which all solar system experiments have been conducted.

If, however, the value of the Christoffe symbol in the same frame of reference is arger, say, in some other domain of space becomes important. For smaller values within he solar system, but in a different reference frame, a still has the same value.

These ideas are in agreement with experi mental results that have been made to test Einstein's theory. Borneas notes the prop ties of the supplementary field as follows: # possible that some effects result from a rapid variation of the metric in some domains of space (perhaps under conditions of gravitaional collapse or due to quasar or cosmic &

This new theory, though untestable direct ly, may produce indirect effects that can be

Shuttle Woes

Shortages of spare parts and delays cause by unexpected repairs are most likely to in-terfere with the National Aeronautics and Space Administration's (NASA) goal of 30 and nual space shuttle launches by 1990, according to a National Research Council panel NASA's chances of meeting the goal of 50 launches per year are "impossible or highly improbable" with four orbiters and "margin al" with a five-orbiter fleet, the panel says. Furthermore, the lack of spare parts or delays caused by unexpected repairs are more likely to limit shuttle launches than will short ages of major units such as external tanks of olid rocket boosters.

Four orbiters could support between 17. and 25 annual launches by about 1990; five orbiters could support between 22 and 31. 8 cording to the Panel to Assess Constraints & Space Shuttle Launch Rates, chaired by William T. Hamilton, a consultant to the Booms Co. and retired vice president and chief of entist of the Boeing Military Airplane Co. NASA's plans, however, call for 24 space shuttle launches per year in 1988, 30 in 1996;

and 40 in 1992. According to the panel's report, "Assess ment of Constraints on Space Shuttle Laund Rates," the external tank, which carries liquid Rates," the external tank, which carries apply three main engines, is "the only major continued the ponent of the [space shuttle system] for which firm planning is in place to attain let els of 24, 80, and 40 flights per year."

"The possibility of major damage to the shuttle and to ground test facilities from engine component failures is high," the panel

gine component failures is high," the pand said, because the shuttle's main engines in clude such advanced, state-of-the-art systems. Stresses on the orbiter structure come into closer to design limits than does a non flight for commercial or military sircraft. Congress asked the panel to examine the constraints on the frequency of shuttle mistions after NASA had requested that funds he diverted from its research and development budget to a new production facility for the shuttle's expendable external fuel tanks. ASA funded the study.

Ice, Oceans, and Isotopes

New ideas on high rates of glaciation and legiaciation have suggested changes in currently accepted ideas about the glacial periods and their causes. At the same time, new studies are being done on deep ocean isotope onation phenomena. These phenomena are similar to those defining glacial periods. and the new studies have raised questions mout paleoclimate analysis for the time span

just preceding the glaciers.

The broad variety of explanations for the lacial epochs in the northern hemisphere beginning about 15 million years ago and the lack of sufficient data on the epochs appear to be the result of low precision in correlation between land and ocean methods. Among the many correlations are factors related to the oxygen isotope temperature scale obtained from analysis of marine invertebrate speci-

ocean temperature, which in turn is related to ice volume. There are radioisotope daughter product ages associated with the fossils, so a scheme of geologic time, fractionation, and temperature/ice volume can be brought into onjunction with terrestrial glacial data and even with global climate trends and the astroomical events responsible for them. This pattern of analysis, described by C. Emiliani almost 30 years ago (Journal of Geology, 63, 538, 1955) is still being widely followed; but the new data on isotope fractionation processes and on paleoclimates are providing a few new twists in interpreting the many areas of the scheme that are characterized by uncer-

Isotope fractionation is related to deep

At least one glaciation period was described as a "pulse" by W. F. Ruddiman and A. Mc-Intyre with rapid rise-times of ice accumulation (Geological Society of America Bulletin, 93, 1273, 1982). J. T. Andrews recently discussed these results as providing "strong support for he Milankovitch hypothesis according to

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Cover. This geoid is the equipotential surface in the terrestrial gravity field that oincides with undisturbed mean sea level stended through the continents. The direction of gravity is perpendicular to the geoid at every point. The geoid is the surface of reference for geodetic leveling and astronomical observations, The Air Force Geophysics Laboratory Geodesy and Gravity Branch has accurately determined the shape of the geold by using SEASAT tellite altimetry and other data derived from satellite tracking and surface gravim etry. This map shows a highly detailed 1° x 1° oceanic geoid derived from interpolation of SEASAT data. The contour interval is Erklardt, Air Force Geophysics Laboratory, Bedford, Mass.)

which northern hemisphere glaciation should coincide with insolation minima—periods when the sun is at its furthest from the earth" (Nature, 303, 21, 1983). Meanwhile, recent

mathematical modeling of carbonate recrystallization in the oceans by J. Killingley (Nature, 301, 594, 1985) suggests that isotope fractionation observations in some preglacial rocks could conceivably be the result of chemical alteration of the sediments instead of the isotopic shifts being in response to changes in ocean water temperature. R. A. Kerr quotes Killingley as saying, "I don't be-lieve it explains all of the observed trends, but the model is so similar, we have to be careful. It's a warning flag" (Science, 220, 807, Evidence for the occurrence of rapid, se-

vere pulses in glaciation in the northern hemisphere is based on benthic fossil age and sotopic measurement, which correlate with insolation minima 231,000 years ago. The insolation minima were on the order of -30 to -40 Δ Langleys (from 1950 values), at latitudes of 10°N, 65°N, and 80°N, all centered at the same age. These minima bisect the interglacial stage 7; thus it is called 7b. Right at substage 7b lies a volcanic ash layer whose 230,000 year age is equivalent to the minimum. The only problem with this correlation, pointed out by Andrews, is that marine isotope state 7 is thought to be a nonglacial period. It is noted, however, that the isotope-temperature-ice growth relation could be uncertain by ±50%. The cooling phenomena could be at the bottom-water level instead of at the

Dating techniques of the terrestrial glaciological record are not accurate enough to confirm the ocean-bottom data. Dating of sea level fluctuations could, perhaps, confirm the volumes of ice needed to support rapid glaciation pulses. Apparently, the suggestion is there, but the complexity of the fluctuations and the required rapidity of the glaciation have caused difficulties. The ice-growth

events are not yet correlated with sea level

The problems of dissolution and recrystallization of benthic forms before consolidation of the sediments in the deep oceans-which would affect isotope fractionation—are probably restricted to much older rocks than would be relevant to the glacial epochs. The isotope data in question are used to truce the record of the climate in the time interval 65-15 million years ago. The techniques of interpreting isotope data as being an indication of climate changes could be complicated by alteration of the sediments if isotopes are exchanged with seawater. Killingley's simulated recrystallization processes can produce iso-tope effects of proportions similar to those observed. The problem of recognizing the degree of alteration in specimens, though,

Polar News

Cores of ocean-bottom sediments and other geological samples collected near and in Antarctica are available for study by qualified scientists, according to the National Science Foundation (NSF). Available are 12,900 m of piston, trigger, and phleger cores from the southern oceans; 4,200 kg of grabbed, trawled, and dredged rock specimens from 600 ship stations; and 1,150 m of drilled cores from the ice-free valleys of southern Victoria Land. Most specimens were obtained

Scientists need not have an NSF grant to ain samples, but proposals for grant support of such studies will be considered by NSF's U.S. Antarctic Research program. For additional information, contact Dennis Cassidy, Curator, Antarctic Marine Geology Research Facility and Core Library, Department of Geology, Florida State University. Tallahassee, FL 32306 (telephone: 904-64-1-2407).

The list of the 161 research projects supported by NSF in fiscal 1982 at the other pole WATER RESOURCES MONOGRAPH 8

The Scientist and

Engineer in Court by Michael D. Bradley (1983)

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entist or the engineer must have a working knowledge of the judicial process and courtroom procedures. This volume, written from a hydrologist's first-hand experiences. offers a complete introduction to the role of an expert witness in litigation proceedings. The Scientist and Engineer in Court is required read-

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Analyzing Natural Systems: Analysis for Regional Residuals— **Environmental Quality** Management

D. J. Basta and B. T. Bower (Eds.), Resources for the Future, Washington, D. C., xv + 546

Reviewed by Peter P. Rogers

A colleague who is the head of a water planning agency in a large neighboring couny and who was under some pressure to use the types of models discussed in this book told me, "You can either guess the input to the models or you can guess the results. As an engineer with long experience with the water systems that I manage I would rather guess the results because I have a feel for what is likely. If I use the models based upon very imperfect data my experience is completely ignored, and who knows what the results really mean."

How this situation has come about is in itself an interesting story and one that should be explored more fully. What were the scien-

This book represents a serious attempt by a group of seven leading practitioners to present the state of the art of the models for environmental quality management in natural systems. This is a very ambitious task for one

Basta, Bower, and their coauthors have done an excellent job in summarizing the state of the art of the models available for analyzing natural systems with an eye to environmental quality management. What a sorry tale they tell. In the terrestrial, the aquatic, and the atmospheric environment the message is the same; the mathematical formulations have run ahead of the conceptual understanding of the underlying processes and the measurement of data on these processes.

une underpinnings of the Pational Environ-mental Protection Act that allowed it to demand scientific analyses that were not possi-ble at that time, or maybe never possible? Why did the scientific community not refuse to collaborate with requests that were patently impossible? The legal or the administrative requirement to carry out modeling studies did, however, seduce many engineers and sci-entists, this reviewer included, to try to do the best they could under the situation. In retrospect, this was a great error because we have allowed air and surface water models to be adopted and be required (in some cases, models are even mentioned by name in the Federal Register), without regard to measuring the ambient environment before predicting effects of man-induced impacts. The engineering and the scientific community are expected to perform analyses and prediction

without a proper scientific base,

The book that is the subject of this review is a Research Paper from Resources for the Future (RFF). Research Papers are studies. and conference papers made available by RFF from the author's typescripts and are in-tended to achieve rapid dissemination of the work for wide review and comment, it may be unfair to comment upon the speediness of the report production, but no work later than

1978 is seriously discussed in the book. volume. A major problem is defining the au-dience. According to the preface

The primary audience for the volume consists of staff members of governmental agencies, enterprises, and consulting firms, the individuals who actually make the analyses to develop strategies for achieving and maintaining ambient environmental quality. The audience is a varied one, ranging from generalist planner with little or no mathematical skills to biologists, ecologists, environmental and sanitary engineers, computer programers. sociologists, to experienced natural systems modelers. Another component of this audience is composed of students and reachers concerned, in one way or another, with assessing the impacts of public and private decisions on natural systems.

Such an audience cannot be addressed successfully in one volume. Only an expert can appreciate the comments given on the applicability of the models; however, an expert would already know these points, and then the treatment is superfluous. The major potential use of the book will be to educate the experts in the areas of terrestrial, aquatic, and atmospheric assessment about the kinds of models available. Groundwater models. however, are not included. It could also serve as a useful reader in upper level undergraduate courses in environmental sciences, provided the instructor is able to provide evaluative

After a general and jargon-laden introduction (chapter i) by Bower and Basta about modeling philosophy, the book moves to a second introduction (chapter 2) by Basta and Moreau, this time about natural systems models. The "new-speak" continues, NSM's, REQM's, and AEQ's abound in this chapter.

While the section "Calibration and Verification" seems to say the right things in the right order, the authors do not appear to be unduly concerned when they report on the typical lack of verification and validation natural systems models receive. What the authors report at this point should have led them to conclude, and print in block capitals in red, "These models do not predict actual likely occurrences of ambient concentrations. It is hazardous to use them directly for practical applications or policy decisions." At this point, the reader gets the impression that the Tianic sank, and nobody noticed, least of all the authors, who continue to row quietly for the other side of the Atlantic

the third chapter is a review of models for residual generation and discharge from ur-ban and nonurban land surfaces by Huber and Heany, who reviewed the literature and reported 73 models known to have been used n this area of environmental modeling. From these 78 they chose 14 models for detailed

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analysis. The chapter is well written, and the material is easy to follow. Again, however, the chapter is weak on evaluation. A complex matrix listing of available models is given which is supposed to help the reader choose which model to use. However, guidance on model selection in given situations and expected reliability would have been a welcome

In chapter 4, Hinson and Basta give an exhaustive review of the "surface receiving water bodies" models. They review 27 models from the literature and use a matrix format similar to Huber and Heany for aiding in the selection of a model. However, after reading this chapter, one is left with no impression as to how well the different models actually

mimic reality. The last chapter, by Muschett on air pollu tion modeling, is extremely well written and quite sophisticated in its treatment. Muschett lists 97 models and claims that there are 33 operational ones. He discusses the accuracy of some of the model parameters, and later he discusses the accuracy of the models them-

The book would have been improved by a final chapter providing an evaluation of the state of the art of environmental modeling. In the reviewer's opinion it should have concluded that the "emperor has no clothes." The scientific community and the community of environmental regulators in government sorely need to be told the truth about models and the current lack of scientific certainty. It is disturbing that the trend toward premature promotion of modeling studies by environmental regulators—most recently for protect-

g groundwater resources—continues. The greatest weakness of the book is the authors' unwillingness, or reluciance, to give strong evaluations of the models. Indeed, the only time they appear to be less than enthusithe simplest "black-box" variety, which require few data and give broad brush answers. These, in the eyes of the authors, should be avoided because they do not provide adequate description of the system. Yet, the more complex models in most cases only de-scribe small parts of the problem in great detail. (If there are over 70 reactions in the production of photochemical smog, how do we know that a model that makes detailed representation of 19 reactions is better than a

model that lumps them all together?) In the end we model what we can model, and we cannot always model what needs to be modeled. Hence, the volume omits longrange transport of air poliutants, the acid rain phenomenon, and also omits the transport of chemicals through groundwater. These are examples of pressing environmental issues that the authors have not addressed. Yet, models that describe the transport of contaminants through groundwater systems do exist. But they too suffer from all the limitations common to the models discussed in the Basta and Bower book.

Peter P. Rogers is with Harvard University,

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Please contact: Dr. C.M. Scarfe, Department of Geology, University of Alberta, Edmonton, Canada T6G 2E3, (408-152-2740) as soon as possible.

Associate Marine Scientist. Responsible for engineering Associate Marine Scientist. Responsible for en-neering development, operation and maintenance of stophisticated underwater acoustic, electronic, navigational and computer hardware used in map-ping the sea floor. Three months per year at sea with equipment. Thorough working knowledge of electronics and aroustles required. Computer experience preferred. Bachelor's (or higher) degree in science or engineering, with 12 or more years exp-rience in development, operation and management of scientific or engineering programs, as well at expertence as chief scientist or program engineer of research cruises. Submit resume to: R. Tyce, Asso-ciate Marine Scientist Position, UNIVERSITY OF RHODE ISLAND, P.O. Box 307, Kingston, Rode Island 02881. Island 02881. An affirmative action/equal opportunity employe

Meteorologisi/State University of New York at Owogo. The Department of Earth Sciences has as opening for a leave-of-absence replacement for the academic year 1983-84 on the meteorology faction of the expected to teach introductry meteorology to a general education population and to be prepared to teach courses (such as dimansively) to our B.S./B.A. meteorology students, Candidate should possess a Ph.D. or show evidence toward Ph.D. completion. Send resume and arrang for three letters of recommendation to be sent by June 30, 1983 to: David J. Thomas, Chalman, Bepartment of Earth Sciences, State University College, Oswego, New York 13128.

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ARS Research Associate

Hydraulic Engineer, GS-810-11 or 12, al the USDA Sedimentation Laboratory, Oxford, Mississippi. Incumbent will develop computer methods for mathematically sint ulating runoff and sediment movement of ntensively cropped agricultural land and study sediment losses from cropland hav ing a range of typical soil, cropping, and topographic conditions at different rainstorm intensities and durations, using ave able experimental field data on erosion. runoff, and sediment size distributions.
Must have expertise in hydraulics of junof flow, sediment transport by water, and computer programming. This is a lent ap pointment not to exceed 2 years. Salary (\$26,959-\$29,374 per annum) based upon ualifications and experience. This is 8 Federal Civil Service position. Applicant must be U.S. citizens. For application pro cedures, contact Venessa Matthews, USDA, ARS, SRAO, HE-1, P.O. BOX 53326, New Orleans, LA 70153. Telephone: (504) 589-4316.

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Search.
Send a letter of application, curriculum vitae and names of three references to:
Chairman, Search Committee
Department of Geological Sciences
Wright State University
Dayton, OH 45435.
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Research Professor in Marine Geoscience/University of Rhode Island. The Graduate School of Oceanography invites applications for a research professorship in Marine Geoscience whose salary and rank are negotiable. Preference will be given to candidates who have clearly demonstrated abilities and interest in, but not necessarily limited to paleomagnetism. The position is funded by contracts and grants, however the research professor holds full faculty rights in addition to other benefits. The paleomagnetic facility at GSO is fully equipped, fully operational and oriented towards rapid measurement of large numbers of soft sedimentary samples. Applications are now open for the position which will become available about January 1, 1984.

Send letters of application, resume, and names and addresses of three professional references to: Roger L. Larson, Graduate School of Oceanography, University of Rhode Island, Narragansett, Rhode Island 02882.

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Physical Oceanography/University of Rhode Island. A postdoctoral research associate position is available starting October 1, 1983 for studies of tropical processes in the Pacific. The research invokes the collection and analysis of data relating to the dynamic topography and zonal pressure gradient of the equatorial current systems as part of a long-term study of ocean influences on climate. Submit resume and professional references by August 15, 1983 to: Dr. D. Randolph Watts, Marine Research Associate II Position, UNIVERSITY OF RHODE ISLAND, P.O. Bux 357, Kingston, Rhode island 02881.

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University of Washington/Climate Dynamics Position. Possible opening for meteorologist with same background in large scale dynamics and experience in use of dynamical models for long range prediction or climate simulation. Three quarter time research faculty (funded by research grants), one quarter time academic laculty (state landed). The successful candidate will lead a research project designed to explore the feasibility of dynamically based long-range weather prediction on timescales of weeks to seasons. The project will be developed in collaboration with faculty members in the Department of Atmospheric Sciences. The position will involve a proportionate share of responsibility for teaching and supervising graduate students in the Atmospheric Sciences. Further information may be obtained by contacting the head of the search committee, Professor J.R. Holton, Telephon (206) 543–4010.

Applicants should send vita, description of re-

Applicants should send vita, description of re-surch and teaching interests, and names of four

references to:

Professor John M. Wallace, Chairman
Department of Atmospheric Sciences AK-40
University of Washington
Seattle, Washington 98195
Deadline for applications is July 31, 1983.
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Marine Research Associate II. Analyze and interpret time series of vertical acoustic travel time and bottom pressure. Prepare progress reports and scientific manuscripts on these results. Assist in planning experiments and participate in scientific cruses. Ph.D. in physical oceanography plus experience in computer programming with times series applications in FORTRAN. Submit application and resume by August 15, 1983, to: Dr. D.R. Watts, Marine Research Associate 11 Position, University of Rhode Island, P.O. Box 957, Kingston, Rhode Island 02881.

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Postdoctoral Position/Naval Postgraduate School.

The Ocean Turbulence Laboratory has available a postdoctoral position for a person interested in the analysis and interpretation of oceanic turbulence data. The tenure is for one to two years. The successful candidate should have a Ph.D. In physical oceanography and although experience with turbulence data is preferable it is not essential. The opportunity for involvement in data gathering expeditions is also available.

Resumes can be sent to Dr. R.G. Lueck, Code

Resumes can be sent to Dr. R.G. Lueck, Code 68Ly, Naval Postgraduate School, Monterey, CA 93940

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Postdocioral Position in Atmospheric Chemistry sud/or Cloud Physics/Georgia Institute of Technol-ogy. Recent Ph.D. scientists interested in the de-velopment of theoretical models to sundy the chem-istration of theoretical models to sundy the chemvelopment of theoretical models to study the chemitry and physics of precipitation are invited to apply to the Georgia Institute of Technology.

The salary is \$18,000/year; period of appointment is one-two years. Applicants should send vita and satement of research interests and the names of two references to: Professor W.L. Chameides. Technology, Atlanta, GA. 30332.

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Howard University/Graduate Faculty Position.
The Department of Geology/Geography invites applications for a tenure-track position in geochemistry at rank of assistant or associate professor beoff graduate research program at Master's level. Desired specialization includes environmental geochemistry, geochronology, isotope geology. Send letter of application, resume and names of three referscas to Dr. David Schwartzman, Department of Geology/Geography, Howard University, D.C.

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Graduate Assistantships/Howard University.

Howard University in Washington, D.C., offers a new graduate program for the M.S. degree in geocience; made possible by a grant from the Gulf Oil Company, Areas of specialization are field geology/ geophysics, geochemistry, and meteorology/hydrology with remote sensing. Some stipends and assistantships are available. Potential students should write to Dr. Eric Christofferson, Department-Washington, D.C. 20059.

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Announcements

Caribbean Tectonics

A Symposium on Neotectonics, Seismicity, and Geologic Hazard in the Caribbean and Venezuela will be held October 23-28, 1983, in Caracas, Venezuela. The symposium will present new data concerning the tectonics of the Caribbean region, including seismological and geological data from Venezuela and the implications for Caribbean plate motions. Among the topics to be covered are seismicity and present-day tectonics of the Carib-

bean; quaternary fault displacements and

present fault activity; geothermal sources and fault activity: geodetic, geochronological, and geomorphological indicators of fault activity: and paleoseismicity, seismic morphogenesis, and geologic hazard. In addition, three field

trips to portions of Venezuela will be offered.
For additional information contact André M. Singer P., Depto. Ciencias de la Tierra. FUNVISIS. Apartado Postal 1892, Caracas 101, Venezuela; telex: 26453.

The symposium, organized by the Venezu-elan Foundation for Seismological Research (FUNVISIS) under the auspices of the 33rd Convention of the Venezuelan Association for the Advancement of Science (ASOVAC), is sponsored by the INQUA Neotectonics

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New AGU Mineral **Physics Committee**

A new Committee on Mineral Physics consisting of Orson Anderson (chairman), Peter Bell, Raymond Jeanloz, Robert Lieberman, Murli Manghnani, Alexandra Navrotsky, Tom Shankland, Joseph E. Smith, and Don-ald Weidner has been approved by the AGU Executive Committee.

The increasing number of research groups in an area that combines the study of mineral properties and solid state sciences (materials research) created the impetus for this new committee. At AGU meetings, mineral physics studies have been included in recent years in sessions of Volcanology, Petrology, and Geochemistry and sessions of Tectonophysics. A portion of the charter for the new committee includes arranging special sessions for mineral physics that would bridge the two sections.

The committee, appointed by AGU President James Van Allen, is now actively engaged in organizing plans to meet with section chairmen and to have topical conferences to provide a focus for mineral physics studies within AGU and the scientific com-

As yet, the discipline boundaries that fall under Mineral Physics are not settled; however, the following fields will be covered in the broaclest sense: (1) physical measurements on minerals, (2) calorimetry, (3) high-pressure mineralogy, (4) defect structure studies, (5) mineral and solids equations of state, (6)

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quantum mechanics of solids, (7) spectral mineralogy, and (8) electrical measurements on minerals.—PMB

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Robert W. Adams, Magdy Ibrahim Amin (H), Brian D. Beckley (O), Teresa S. Bowers (V), Jean Burrus (O), Scott L. Davies (T), Roy K. Dokka (T), Robt L. Edwards (O), Virgil Allen Frizzell (V), Roger Hart (V), Michael M. Herron (V), Masahiko Honda, J. Michael M. Herron (V), Masahiko Honda, J. Michael Kelly (H), Philippe Lambert (P), William W. L. Lee (H), Chikao Nagasawa (A), Robert O. Pepin (P), Patricia A. Savage (V), Gordon E. Schacher (A), Timothy J. Shaw (O), Steve Slaff (V), Tammy King Walsh (O), Peter D. Walsh (H), Yongping Zhang (H), Bao-Zhen Zhu (A)

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Radio Solence Fublished six times a year. Akira ishimaru, Editor, 1100 pages anticipated for 1983.
Teotonics Published bi-monthly. The newest addition to AGU's family of presigious journals. Teotonics is devoted to publishing leading papers in the structure and evolution of the terrestrial lithosphere, integrative tectonics, structural geology, and meterials science. Editor, John F. Deway, 600 pages anticipated for 1983.

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Exploration Geophysics

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J.G. Wegi (Theoretical Geophysics Group, National Cophysical Resourch Institute, Uppal Road, Hyderabad 500 007, (ndia) F.K. Agrewal, and K.H.F. Rao

The estimation of thickness of trap rocks in the earthquaks—affacted Knyna eres is an important permeter for revealing the topography that existed affors the Deccan volcanism. In the present work, a case bostory is presented delineating a three-dimensional block model for the Knyna eres by the spectral analysis of marchagenic data. The thickness is the area was found to vary from 700 to 2200 m, which coreplates well with the results of other geophysical investigations.

ONTH Constraint or miscellaneous HILIPTCAL AMISOTROPY—ITS SEMIFICANCE AND MEANING I. Selbig (institute voor Aardwatenschappen, belagetlam 4, Postbus 80.021, 3508 TA Utracht, The Enterlands A. Postbus 80.021, 3508 TA Utracht, The Enterlands Institute of the superoximately elliptical. However, it traceversely isotropic media only the wavefront of SI waves is another an ellipsoid, and the wavefront of SI waves is another allipsoid, and the wavefront of SI waves is another allipsoid, and the wavefront of SI waves is another allipsoid, and the wavefront of SI waves is an oblate ellipsoid, and the wavefront of SI waves is an oblate ellipsoid if and only if the appreciation (Ci.-Ca.)(C'.:-Ca.)-(Ci.-Ca.) wantabes. This cannot happen if the anisotropy is due to insiliation (periodic layering with a spatial periodical is comparison to the wavelength). The occurrence of olliptical wavefronts cannot be detected on the basis of surface observations of times slows, since the complete wavefronts averywhere by simple stratching of layers. Meither arrivel times nor appurent slownesses (and thus Snell's law) are affected by this transfereaction. All concepts and algorithms typicals to spherical wavefronts are applicable to elliptical wavefronts, in particular the determination ell weekfronts are applicable to elliptical wavefronts, in particular the determination of a weekfry se the sero-offset limit of the stacking velocity as the sero-offset of limit of the stacking velocity as the sero-offset of limit of the stacking velocity as the sero-offset limit of the stacking velocity as the se

chicropy.

Although the wavefronce of P and SV waves can never leading the wavefronce of P and SV waves can never leading to the enlanceropy is the result of implication, pieces of the wavefronce can be represented with anficient accuracy by an ellipsoid. This representation allows a simple determination of the ratio "here-offere limit of stacking velocity/wartical ratiosity." Constraints on the parameters of the thin layers that constitute a lamelisted andium can be translated into constraints of the above velocity ratio. For P waves this ratio is centered around unity for a wide range of constituent parameters.

GOYGTSICS, VOL. 48, NO. 7

Hydrology

132 Oromoter (Irrigation)
132 Oromoter (Irrigation)
13. PROMOTICAL MOMEL FOR SOUDER STRIP IRRIGATION
1, I. Veir (Applied Mathematics Division, LGIM,
1, 0, 82 1335, Wellington, New Zealand).
A Almestic wave nodel is developed to discuss raface irrigation when the infiltration function regulated is a long time gravity term plus a discontinuous short time capilliary or sorbilvity term. De corresponding modal equations are solved captly for the depletion, recomming and advance issues until the arrival of the depletion arrival approach was needed. The kinesatic wave kinion is used to derive a condition for the validity of the corresponding Levis-Miles problem, and using the shellow water equations a condition is injusted for the validity of our himmatic wave solution. The kinesatic wave solution. The kinesatic wave solution. The kinesatic wave solution. The kinesatic wave indicated for the validity of currently are solution in determined by these non-dimensional parameters whose infiltence is displayed graphically. (Irrigation, border trip, thematic wave) er Resour, Res., Paper 3M0725

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Refert B. CONTENT USDA-ARS, Southwest Rangeland
Vitershed Research Center, Tucson, AZ. 85719)
Areal extent are important in the southwestern United
National Content and Indied Content of the Cont Makes to engineers, hydrologists, metapologists, and others concerned with the frequency, megnitude, duration, and distribution of thunderstorm reinfall-later from two dense reingage networks, one in southers cased to establish expected occurrences of high variability in such occurrences. Expected occurrences and durations above various thresholds were determined for both point and area for each location.

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Meteorology

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ASSESSENT OF THE CONTRIBUTION OF DIFFERENTIAL
POLARIZATION TO IMPROVED RAINPALL MEASUREMENTS
C.W. Ulbrich (Clemen University, Clemen, S.C.
28631) and D. Atlan
A description is given of the effects of variations in the shape or breadth of the drop size
distribution (DSD) on rainfail parameters deduced
from a measurement technique which employs the
differential reflectivity factor Zpg and the refiectivity factor at horizontal polarization Zp.
The mathematical form of the USD used is a games
distribution. Justification for such a form is
given through consideration of varying DSD shape
in nature as implied by the results of empirical
analyses of other workers. Theoretical expressions are derived for rainfail rate R, liquid
water content M, and median volume diameter Do
in torms of Zpg. Zq and size distribution dependent factors. These expressions are used to
assess quantitatively the effects of changes in
DSD breath on values of R, W and D, deduced from
Zpg and Zy. They are also used to show the
effects of measurement errors in Zpg and Zy on R,
W and Dg. The potential improvement in accuracy
which is possible when account is taken of DSD
shape variations is shown by situalizing Tpgs. Zyl
dual-measurement method using experimental raindrop site spectra. Mathods by which DSD shape
variations could be detected through the use of a
third remote measurable are discussed.
Rad. Sci., Paper JEOSI)

3799 General (Soler-Terrestrial Melationships) CORDENTS ON "EVIDENCE FOR A SOLAR CYCLE SIGNAL IN TROPOSPERRIC WITHOS" D. E. Yeans (Control Data Corporation, P.O. Box 1249, Minnampolie, MN 55440), G. D. Mastros and A. D. Bel-

mont
In a previous paper it was suggested that a substantial li-year period solar cycle influence may exist in
tropospheric wind and temperature data. The currant
study remanlysms a subset of the original data with
the intent of better sensesing the significance of the
reported correlations. Extensive use is made of empirical testing; also employed is a maximum entropy
spectral samiyate. The new findings indicate that the
correlations between the 10.7 cm solar fire and 300 mb
winter winds are not statistically significant. An
upper lists on the porcentage of variance in chees upper limit on the percentage of variance in these winds which is explainable by a solar cycle influence is suggested to be ~82. (Solar-terrestrial, climatology)

J. Goophys. Res., Green, Paper 3C0796

Oceanography

4703 Boundary Layer EFFECTS OF THEM-VARYING VISCOSITY ON OSCILLATORY TURBULRY CHAMPEL FLOW J. W. Lavelle (WDAA/Facific Harine Environmental Lab., 3711 15th Ave. N.E., Seattle, WA 98105), K. O.

Lab., 3711 15th Ave. N.E., Seattle, WA 98105), N. O. Hoffeld
A semi-analytic model of a time-dependent bottom boundary layer has been constructed to which flow and time-variable addy viscosity are interdependent. Revinuited in the case of onetliatory forcing at tidal frequencies, the model shows that neglecting time-variation is viscosity results in underestimate of maximum bottom stress and disturtion of the flew profile mear times of flow variable wiscosity also add terms proportional to min(s/s) and a to the conventional standy-state ln(s/s) profile near the bottom. Inferences assed on the logarithmic profile for measurements made in time-dependent boundary layers may consequently yield inaccurate estimates of roughness langth and friction valority. Stream is seen to leg flow at points away from the bottom, as has been observed in measurements, though bettom stress always leads flow aloft. Bottom stress is found to depend insertly on the frace-stream velocity in the limit of time-invariant viscosity, bottom stress is more mearly quadratic. The friction coefficients are reasonably time-independent only when the phase lead, 0, between bottom stress, Tg, and frace-atream velocity, U, is incorporated inth the bottom friction expression. A generalized bottom dreg lew for oscillatory flow encompassing-all these features takes the fear T, at all (1740) U(1740), where \$\beta\$ has a value batten of all 1, and 6 is typically a few tens of degrass. In the examples evel loated, hence \$\beta\$ are a value batten of all 1, and 6 is typically a few tens of degrass. In the examples evel loated, hence \$\beta\$ are a value batten of \$\beta\$ (conventionally called C), ranges from 1-5 x 10^{-2}, the variation in both cased depending on x 10^{-2}, the variation in both cased depending on x 10^{-2}. n 1 I (convention) to the case depending on surface Bossby qusher. (Oscillatory boundary layer, tidal flow, bottom friction, flow profiles). J. Geophys. Ses., Green, Paper 300704

4760 Sea Ice (Emissivity)
SEA ICE EFFECTIVE MICROVAVE EMISSIVITIES FROM SATELLITE
PASSIVE MICROVAVE AND IMFRARCO OBSERVATIONS
J.C. Comino (Goddard Laboratory for Atmospheric Sciences,
MASA/Goddard Space Flight Center, Greenbelt, MD 20771)
Microwave sea ice emissivities are investigated on a
global scale using mear simultaneous images from the
dual-polarization Scanning Multichannel Microwave Radiometer (SMR) and the Temperature Humidity Infrared
Radiometer (IMIR), both on board the Mimbus-7 stellit.
The emissivities in several study areas in the Arctic
region are observed to be approximately constant during
a nine-month period within the fall, winter, and spring
months, for both first year and multipear ice, with a
standard deviation of about 35. Unring the omset of
summer, when the snew cover starts to melt, increases
of about 305 in mmissivities are observed at 37 kHz
for multipear ice with the effect decreasing to less
than EX at the 6.6 GHz chamels. Multichannel cluster
analysis over very large stardy areas during winter
shows considerable variability in emissivities of well
defined clusters of commolidated ice at 37 GHz and
about one-third as mich at 18 GHz. Some monlinear;
ties in the functional relationship of the emissivities
in the consolidated ice regions between first-year and
multiyear ice are also myldght, aspecially when data
from one frequency is plotted against that of monthar.
However, the cluster analysis technique separates, the
various maissivity data points into distinct clusters
our supponding to radiometrically different ice types
in addition to improving the capability of classifying ice by age, information about onefree decreasing and surface characteristics wight also be obtainable.
(Sen ice, emissivity, Sen, IRIR).
I. Geophys. Res., Creen, Paper 300666:

Meteorology

3780 Climatology

REFLECTANCE CHARAVTERISTICS OF UNIFICE! EARTH AND CLOUD

SURFACES DERIVED FROM HIRBUR-7 ERB

V. R. TRAJOR (NOAM/Rational Earth Satellite Data and
Information Service, Washington D. C., 20233) and
L. L. Stove

Data from the scanning channels of the Nimbus-7 Earth

Redistries Budget(RRs) superiment are combined with
Chief data on Earth surface conditions and cloudinass.
Patterns of bi-girections: reflectances are constructed
from this data for uniform Earth and cloud surfaces.
Examples are shown that illustrate the bi-directions.
Properties of surfaces and how these wary with solar
shown.

Conclusions may be summarized as follows: (1) Water
surfaces subhibit limb brightening at all SZAs; (2) Cloud
and land surfaces and show these wary with solar
surfaces subhibit limb brightening at all SZAs; (2) Cloud
and land surfaces (3) The land surface
exhibits higher beckerd reflection for SZAs less than
about 90°; (4) All of the surfaces; (5) Sow 18 the cost
more specular as SZA increases; (5) Sow 18 the cost
more specular as SZA increases; (7) The land surface
subject for these surfaces; (6) Sow albedo
shows very little variation with SZA and even shows a
slight decrease over a limited reque; (7) Libedo
generally increpte; (9) The singular patterns developed in
this study are in qualitative agreement with these from
other investigations. (8:-directional reflectance,
albedo, radiation budget).

J. Geophys. Res., Green, Paper 300525

J. Geophys. Ras., Green, Faper 100735

4770 Turbulence and diffusion

OCEAMIC TURBULENCE: BIG RANGE OR CHITHUOUS CREATION

D. R. Caldwell (School of Greenography, Greens State
University, Corveilis, Oregon, 97111)

In a discussion of the turbulence characteristics of
patches of "microstructure" in the Goesn, the hypochasis advocated by Gibbon (1982), that the patches
are produced by very rare but estremely powerful
turbulence-generating ovents which unually have
"fossilized" before their observation, is contrasted
with the hypothonis of a turbulence field driven at
the time and scale at which it is observed. In this
"continuous-creation" notion, by no seems original
hare, the driving energy is converted to turbulence
kinetic anarry in such a way that the observed overturning thickness scale, Lp. is linearly related to
the leasth scale (t/N²)*, where is the kineticenergy dissipation rate and N is the brougancy
frequency. [This relationship does not hold in
boundary layers, where shoother length scale, the
distance from the boundary, is imposed,) If the
time scale of the largest vertical oddies is N⁻¹,
the paraseters of turbulence and its affects can be
eatisated by the measurement of N and Lp. For
example the Kinetic energy dissipation rate would be
proportional to L¹³⁵ and the vertical eddy diffusivtive sould be proportional to L¹⁶⁵ energy dissipation rate would be
proportional to L¹⁶⁵ energy dissipation rate would be
proportional to L¹⁶⁵ energy dissipation rate would be
proportional to chemistry of the interproportion of sicrostruous dates.

J. Geophys. Res., Green, Fapar 300714

Particles and Fields— Ionosphere

5560 Particle precipitation
WHESTLER INDUCED CHARGED PARTICLE PRECIPITATION AND DISTORTION OF GEOMAGNETIC FIRED
R.H. Singh (Applied Physics Section,
Institute of Technology, Banaras Hindu
University, Varanasi 221005, India) and
R. Presed

University, Varanasi 221005, India) and R. Prasad
The geomagnetic field is invariably distorted because of the interaction with the solar wind. The magnitude ard morphology of geomagnetic field distortion changes with the solar wind velocity, solar particle flux, magnitude and direction of frozen-in interplanetary magnetic field. Effect of these distortions in the geomagnetic field on whistler wave interaction with energetic charged particles has been studied. Predipitated charged particles has been studied. Predipitated charged particle influx has been found to increase with enhanced geographic field distortions. It is envisaged that the changes in precipitated electron influx might carry the signatures of geomagnetic field distortions. The morphological features of precipitated charged particles, auroral display, breasstrahlung flux and optical emissions may be interpreted with the changes in the solar wind interaction with geomagnetic field and its day to day variations. (electron precipitation, wave-particle interaction, pitch angle scattering, geomagnetic field distortion).

J. Geophys. Res., Blus, Paper 340721

J. Gauphys. Res., Blue, Paper 340721

Sign Mayo propagation
STAMDIKE WAVE PATTERNS IN VIF HYSS
R. Britain (School of Electrical Engineering,
Cornell University, Tithaca, New York, 14853),
P. N. Kinnear, M. C. Kelley, J. C. Siren, and
B. L. Carpenter
Chaeryations have been unde of systematic patterns
in VIF hiss, which can be interpreted as a standing
save pattern formed by reflection in the lower ionosphere. Multicomponent VIF electric and magnetic
field experiments were flown on three sounding rockets
(Mito-Tomahawk 18, 203-205) from Siple station, Antarctica during December 1980-Innuary 1981. One feature
of the natural emissions was observed in a very similar
form during such filight. A bend of hiss, typically
from 1.5-3 kHz, with seen on the uples to form a series
of closely spaced stripes with whistler-ILM dispursion.
These first appeared at an altitude of 90-95 km and
carended for as such as 40 km in sititude. On the
downing the stripes were observed at the sman slittude
with the pattern reversed in time. We such pattern
were observed by the VLF receivers operating at the
saws time on the ground at Siphs or at the coajugate
point. It is sungested that the patterns are interference effects due to downcoming valves reflecting from
a layer in the R-region and forming a standing wave
pattern. The observed stripes are then due to the
rocket traversing the standing wave pattern in apposite
directions on upleg and downing. If this interpretation
is correct, the fringe specing should be related to the
seventeeth and nevertee as electated on the pattern. directions on upley and covering. It this interpretation is correct, the frings specing should be related to the wavelength and permits a calculation of the refractive index. In one example we calculate me43. In good agreement with two independent determinant long of the refractive index. (VLP hims, standing waves).

J. Geophys, Ram., Blue, Paper 3A6807

Particles and Fields-Magnetosphere

5720 Interactions between solar wind and magnatosphure sugmandal sugmantages of THE DAYSIDE RECONSECTION M. Hoskine (Institute of Space and Astronautical Eclases, Ecnaha, Magro, Tokyo 153, Japen) and A. Highlia To assains the basis characteristics of reconsection on the dayside segmentages, we have measurately studied the reconsection process at an interface where the total pressure is in balance but the thorsal pressure is higher on one wide these or the other. Becambaction is caused by quomalous resistivity that is assumed to oppress only in a localized region at the interface. Boundaries are secured to be free boundaries but reflection of the parturbations originating from inside the equalities region is suppressed by pleasing as absorbing region. Beamlis can be appressed as foliops, denoting the high pressure and low pressure regions as approtected; (1) A slew shoot is formed in magnatosphare and a slow separation face formed in magnatosphare (2). At the slow shoot the Levelti force and pressure gradient are of comparable importance in succlibration depends on the direction of the Interplanetary Magnatio Fals (1917) and when the reconnection, link is second to be direction of the later and lat

工程的工具的现在分词使用的工程的基本的

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October 3-7, 1983 Los Alamos, New Mexico Convenor: E. W. Hones, Jr.

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the velocity of the aggelerated places is roughly proportional to sin²(3) + sin²(3). (magnetopause magnetosphere, reconsistion, slow espension, slow J. Caophys. Fes., Blue, Paper 3A0808

sphere)
AN 1978-3 HIGH TIME RESOLUTION SYDDY OF INTERPLANETARY PARAMETER CORRELATIONS WITH MAGNITOSPERPIC ACTIVITY D. N. Balvar (Los Alacos National Laboratory, Los Alacos, NM 87545), R. D. Zwieki, S. J. Bans, R. M. Blous, Jr. B. T. Taurutani, E. J. Smith, and 3.-1. Arasofu
From 1978 to 1982 the ISE2-3 spacecraft was in a "halo" orbit stound the summerst lagrangian point, Li, approximately 240 Rg upatress of the sath and was continuously in the upstress solar wind. In order to evaluate the efficacy of such a spacecraft as a real-time interplanetary monitor to predict substorm activity and to measure solar wind amergy input into the tarrestrial superiosphere, three periods in 1978 were selected in which to perform detailed correlation analyses between solar wind and interplanetary aggostic field (1NT) parameters and negostospheric activity indices and a AZ and Dat. dight-time resolution (I-min) avarages of combined solar wind parameters and DD parameters are used to perform linear cross-correlation analyses with the similarly avaraged magnatospheric activity indices. A significant departmenter (t. 72, V2m.) produce high (0,7-0.8), meanly identical linear conveletion coefficients with AZ. During distorbed times unbetantically lower correlations between all parameters and AE are found (T S 0,6 for VBg; r S 0.4 for c). A suspending both auroral and ring convent seems is useful and can be meaningfully calculated during distorbed periods of geomagnetic activity indicated periods of trather highly correlated (r O.6.) with all tested parameters during distorbed times. The parameters in prediction of Ur. Motably, we find that the typical intrinsic 23-60 minute delay between intemplanetary parameters and amagnatospheric response during quiet pariods diminishs to S 15 ninutes during distorbed times. (Geomagnetic activity, calar wind compliance).

J. Geophys. Res., Siue, Paper 110718

FARTICIE AND WAVE DYMMICS DURING PLASMA INJECTIONS N. G. Koons (Space Eclences Laboratory, The Aerospace Corporation, P. O. Box 92957, Los Angales, California, 900099; J. F. Funsali

The SCATEA establize measures particle and were parameters as it moves cathound on the donk side from the plasma sheat. In many cases plasma waves are not observed in the quientant plasma sheat prior to a plasma injection. The alactron distribution function prior to destry into the plasma sheat is a meanly isotropic cost appetrum, J(E) ~ 1/E. Just inside the plasma sheat is a meanly isotropic cost appetrum, J(E) ~ 1/E. Just inside the plasma sheat is a meanly isotropic, J, > J. As the establite pennetrates desper late the plasma sheet the spectrum further hardens, especially near as ~ 90°. At the injection the electron spectrum travitably hardens and often becomes pasted in the law energy range. The place anisotropy is further entanced in lawor of J. The plasma wave aslasions even cocurred at the time of the injection. Mhistler-mode waves are ubsarved below the electron cyclotrom frequency. Electropic title waves are discated in land between the slagtroctatic waves are datected in bands i trom cyclotrom fraquency harmonics. J. Geophys. Res., Blue, Paper 3A0771

5760 Convection
SELF-COSSISTENT TREORY OF THEER-DIMENSIONAL CONMECTION IN THE COOMAGNETIC TAIL
J. Bira and K. Schiadier (Theoretische Physik IV,
Embr-Universität Sechum, 4630 Sochum, F.R.G.)
The self-consistent Cheory of time-dependent conminute of the control of the dependent conminute of the control of the dependent conminute of the control of the dependent con-J. Bira and K. Schiadler (Theoretische Physik IV, Buhr-Universität Bochus, 4630 Bochus, F.R.G.)
The self-consistent theory of time-dependent convection in the earth's magnetotall of Schiadler and Sim (1982) is estanded to three discensions to include more realistic tell geometry, and three-dimensional flow. We confirm, that a steady state mointion implies unrealistic tell geometry or large particle or emergy losses that are unrealistic during quiet times and conclude therefore as in the 2-D mass that the magnetotal becomes time-dependent for typical convection electric fields. Explicit solutions are derived, even smilytically, for the three-dimensional flow and the electric end magnetic field in a realistic tell geometry and quantitative brumples are presented. Consequences of time-dependent convection are demonstrated considering two idealized cases of magnetosphera response to noise wind chauges, (A) uniform demonships that response to noise wind chauges, (A) uniform demonships and (B) compression only in the a-direction perpendicular to the planes sheat as the probable consequence of a dann to dusk erternal electric field (E, ') O corresponding to a continuity properties do not charge very sock in time while case (B) leads to an evolution toward installity, nonsistent with the observed correlation of B, C or E, O vich geometry presented in the 2-D theory, was confirmed.

J. Geophys. Rep., Elia, Faper 140742

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